

RECENT REPORTS OF GEOLOGICAL SURVEYS.¹

Cleavage.

THE subject of rock cleavage is one of perennial interest; only a short time ago were Dr. Becker's views noticed in these columns, views founded upon experiment and analysis. Now, Dr. Leith (1) lays before us his reading of the same problems after attacking them by the way of micro-sections and field observations. The author makes the term "rock cleavage" very comprehensive; he recognises among cleavable rocks two broad divisions, which he calls respectively protoclase, or original cleavage rock, and metaclase, or secondary cleavage rock. The former class includes such structures as bedding in sediments and flow structure in lavas; the latter class is considered under the heads "fracture cleavage" and "flow cleavage." Fracture cleavage is conditioned by the existence of incipient or cemented and welded parallel fractures, and is independent of the parallel arrangement of the mineral constituents. Flow cleavage is conditioned solely by a parallel arrangement of the minerals. The one is a phenomenon of the zone of fracture, the other of the zone of flowage in the lithosphere. Fracture cleavage is made to include, wholly or in part, those structures that have been variously described as close-joint-cleavage, false

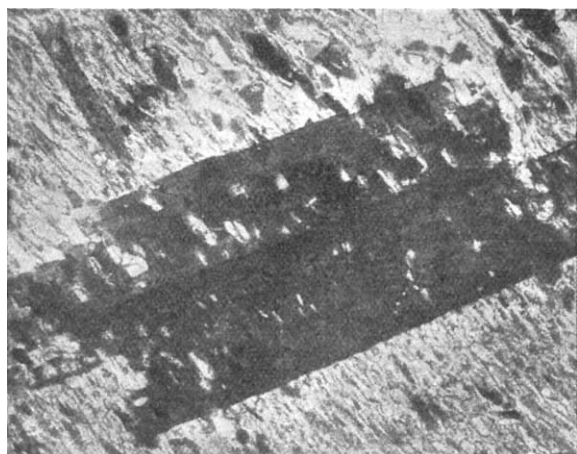


FIG. 1.—Porphyritic constituents developed after rock flowage has ceased. Chloritoid crystal. (Bulletin 239.)

cleavage, strain-slip-cleavage, slip cleavage, ausweichungs cleavage, rift and fissility in part (the term is retained for closely spaced parallel partings). Flow cleavage includes, wholly or in part, the ultimate cleavage of Sorby, "cleavage" of most authors, slaty cleavage, schistosity, and parallel structures in certain gneisses. Flow cleavage is a molecular phenomenon, and the dominating factor in its production is re-crystallisation. Much space is devoted to the study of the behaviour of the more important rock-forming minerals in relation to the direction of the cleavage in rocks, and many thin slices have been examined to determine how far there existed a parallelism between the

cleavage of the rock and dimensional and vector properties of given mineral species.

The bulletin is evidently the result of a great deal of work, and contains a clear statement of the author's views; the illustrations are excellent, and it must be read by all interested in the subject, but it cannot be said greatly to advance our knowledge.

The Geology of Cements.

Several reports have appeared from time to time dealing with the raw cement materials of individual States; in Bulletin No. 243, E. C. Eckel (2) summarises the available information for the United States as a whole. "The object has been to treat the subject from the geological rather than from the technical standpoint, although the technology of the cement manufacture is also discussed with sufficient fulness for the purpose of the report." While mainly a compilation, and bearing the impress of composite authorship, there is in this volume an air of freshness about the facts and of uniformity about their presentation which is doubtless due to the circumstance that Mr. Eckel personally visited every district in which cement is being produced, and examined nearly every plant in operation. Nor were the undeveloped deposits of cement material neglected.

The bulk of the report is devoted to Portland cement materials in the several States; the geological characters and relationships of the limestones, clays, and natural cement rock are clearly explained, abundant analyses are shown, and the peculiar local conditions of transport and fuel, as well as the available markets, are briefly discussed. The cement materials are derived from rocks of the most diverse geological age, ranging from Cambrian up to recent marls and alluvial silts. Short sections are given to the "natural" cement resources and to the Puzzolan cements. We noticed in the section on the grinding of raw materials no reference to the influence of the degree of fineness upon the temperature required for a suitable clinker.

General Geology.

The average British geologist, if his range of vision is not quite limited by the importance of the exposure in his own back garden, if he can momentarily turn from pebble-picking and the unravelling of zones, may enjoy by following Prof. Russell across central Oregon, a pleasant and profitable, if somewhat tantalising, hour. The region included in this preliminary report (3) comprises the country between the Snake River on the east and the Cascade Range on the west, and thus takes in the extreme northern part of the Great Basin.

The predominant rocks of central Oregon are volcanic; an older series of rhyolites and andesites is succeeded by a younger series of basaltic rocks, which are again followed in the Pauline Lake district by andesitic outbursts. The oldest of the rocks dates from early Tertiary times; the youngest may be only a few centuries old.

The sedimentary rocks are represented by soft clays, sands and volcanic dust of Tertiary age. The most conspicuous elevations in central Oregon are of volcanic origin; many are old worn-down craters and peaks, but young volcanoes, particularly as the Cascades are approached, are exceedingly abundant. "Their cones, so recent in numerous instances that erosion has not yet broken their crater rims, are so numerous that 50 or more may frequently be counted in a single view, while a change of a few miles in the position of the observer brings perhaps as many more within the range of vision."

Many interesting features in the water supply and drainage of the country are described in these pages, but none exceeds in interest the fascinating story of the Deschutes River, about the point where it is joined by its tributary the Crooked River. First we find that the Deschutes in Tertiary times had eroded a great valley twenty to thirty miles wide in parts; then most of this valley was filled to a depth of more than 700 feet by water-borne volcanic dust and lapilli with a little sand and clay; this was followed by a sheet of basalt some 80 feet thick. Displaced in this way from their old courses, the Deschutes and its tributaries cut fresh channels and made canyons in the new material 800 feet deep and about one mile wide, until

¹ (1) Bulletin 239, 1905, "Rock Cleavage." By C. K. Leith.

(2) Bulletin 243, 1905, "Cement Materials and Industry." By E. C. Eckel.

(3) Bulletin 252, 1905, "Preliminary Report on the Geology and Water Resources of Central Oregon." By I. C. Russell.

(4) Bulletin 235, 1904, "A Geological Reconnaissance across the Cascade Range." By G. O. Smith and F. C. Calkins.

(5) Bulletin 242, 1904, "Geology of the Hudson Valley between the Hoosic and the Kinderhook." By T. N. Dale.

(6) Bulletin 254, 1904, "Report of Progress in the Geological Re-survey of the Cripple Creek District, Colorado." By Waldemar Lindgren and F. L. Ransome.

(7) Bulletin 237, 1905, "Petrography and Geology of the Igneous Rocks of the Highwood Mountains, Montana." By L. V. Pirsson.

(8) Twenty-fifth Annual Report of the U.S. Geological Survey, 1903-4.

(9) Indiana, Department of Geology and Natural Resources, Twenty-ninth Annual Report, 1904. By W. S. Blatchley.

(10) Canada: Summary Report of the Geological Survey Department of Canada for the Calendar year 1904 (1905).

once more an outburst of basaltic lava filled up the canyons to a depth of at least 500 feet. Still in their old courses, but displaced from their channels, the streams had again to commence re-excavation. At the present time they have cut through more than 500 feet of the hard basalt without reaching its bottom. The two periods of canyon cutting probably belong to the "Sierran" epoch of Le Conte.

Hot springs, desert conditions, glaciation, and the in-

irregular plates as one of the last products of crystallisation. The authors conclude that volcanic and plutonic rocks alike may have been derived from a homogeneous magma, low in alkalis, with soda predominating over potash; hence they may belong to the same province as the rocks of the southern Cascades and the Sierra Nevada.

Dr. Dale has written a short account of the stratigraphy of a strip of the Hudson Valley (5) between the Hudson River on the west and the Rensselaer Plateau and the Taconic Range on the east. The difficulties in the way of delimiting the age and relations of the several formations are the rarity and bad preservation of the fossils, the repeated minor overfolding, and the prevalence of Glacial drift. An excellent map accompanies the paper on the scale of 1 inch to the mile; fossil localities and good outcrops are clearly indicated by a system of coloured spots—a plan worthy of imitation.

The formations represented are Lower Cambrian, Beekmantown shale with *Dictyonema* and *Clonagraptus*, the Hudson shale and Hudson schist (Ordovician=Trenton), and the Silurian Rensselaer Grit=Oneida, Medina.

Three crustal movements are recognised in the area:—(a) at the close of the Lower Cambrian, Upper and Middle Cambrian are missing; (b) the Taconic or Green Mountain movement which folded the Ordovician beds; (c) a post-Devonian or Carboniferous movement which folded the Silurian Grit of the Rensselaer Plateau. Minor oscillations

are indicated by conglomerates which occur in the Lower Cambrian, in the Hudson shale, and in the Rensselaer Grit.

Although only ten years had elapsed since Cross and Penrose made a careful study of the Cripple Creek district, the people of Colorado asked for a re-survey on account of the great development of underground working in the interval; this re-survey has been undertaken by Messrs.



FIG. 2.—View of double-crested moraine on south-side of Hayden Glacier, looking west. (Bulletin 252.)

fluence of domestic animals upon river erosion form the subjects of notes. The illustrations are beautiful, and helpful to the text.

The region about the northern limit of the Cascade Range was traversed by Messrs. G. O. Smith and F. C. Calkins (4) in a rapid reconnaissance. The older rocks encountered are grouped together as pre-Cretaceous, comprising (1) old-looking schists along the Columbia River and lower Okanogan Valley; (2) supposed Carboniferous sediments with volcanics in the more northern part of the Okanogan Valley; (3) strata similar to the last mentioned exposed in the base of the upper Skagit River; (4) some old sediments and a great volcanic mass near Hamilton; and (5) a great assemblage of strata ranging from Palæozoic to Jurassic lying to the west and north of Mt. Baker.

An extensive development of the Cretaceous is indicated from the Hozomeen Range on the west to the Similkameen Range on the east; the name "Pasayten formation" is proposed for this in place of Prof. Russell's term Similkameen. Sandstones and shales predominate; contemporaneous igneous rocks appear to be absent. Tertiary sediments occupy a much smaller area than do the Cretaceous, but volcanic rocks, presumably of this age, are of some importance. Later formations are represented by glacial and river gravels, and by the andesitic lavas of Mt. Baker.

As compared with their immense importance in the southern Cascades, the part played by volcanic rocks in the boundary section appears very subordinate. Plutonic rocks are greatly developed, the prevailing type being a "grano-diorite." The volcanic rocks range from sodarhyolite, dacite, acid and basic andesites, to basalt. The dyke rocks include a soda-syenite from south of Bighorn Peak, and a diorite (?) in which apatite occurs in broad,

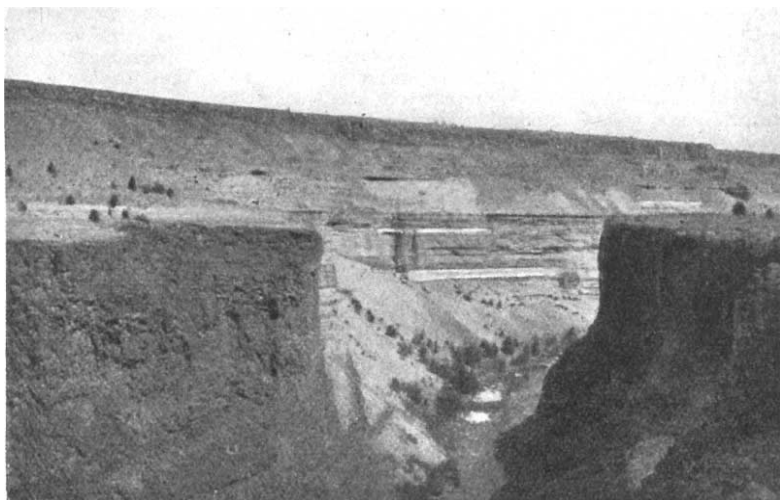


FIG. 3.—View in Opal Canyon, Crooked River, Crook County, showing basalt of inner canyon in contact with stratified beds of outer canyon. (Bulletin 252.)

Lindgren and Ransome, who have now issued a report of progress (6) in advance of the laboratory examinations.

The oldest rocks in the district are the muscovite and fibrolite schists; these are closely associated with fine-grained granitic gneiss. Both gneiss and schist are cut by a reddish granite. A second type of granite is the coarsely porphyritic Pikes Peak type. As a result of the recent work, the views of Cross upon the rocks erupted

from the Cripple Creek volcanic centre are somewhat modified; the various rock types recognised by him are shown to be linked by intermediate forms; they are clearly all divergent eruptive facies of one general magma, characterised by containing from 9 per cent. to 15 per cent. of potash and soda, the soda being always somewhat higher than the potash; no true andesite is recognised. Most of the ore has come from the central area of phonolitic breccia.

The bulk of the telluride ore-bodies is in fissure veins, either simple or complex, being closely spaced and linked together, constituting what is called a "sheeted zone." The fissures radiate from a point to the north of the area; they are uniformly narrow, therefore the amount of gangue and ore is comparatively small. Quartz, fluorspar, and other minerals usually line the walls of the fissures; the rich tellurides are generally the last minerals to form. The authors consider that the unoxidised ore deposits represent the product of one period of general mineralisation not appreciably modified by any secondary enrichment. The last exhalation of the Cripple Creek volcano seems to be a mixture of nitrogen with about 20 per cent. of carbon dioxide and a small amount of oxygen. The gas increases in quantity with the depth, and in some cases interferes seriously with mining operations.

An interesting description of the petrography of the Highwood Mountains of Montana (7) is given by Prof. Pirsson. This region is occupied by a greatly eroded group of volcanoes which were in activity at some time subsequent to the Lower Cretaceous; several necks (stocks) are exposed, and now stand up as prominent peaks. Highwood Peak, the highest point in the group, is composed of syenite (pulsakose) and monzonite (shoshonose); in East Peak the rock is a basic leucite syenite. The Shonkin stock is shown to consist of Missourite, passing by intermediate stages into shonkinite. The Arnoux stock is important as the source of a new variety, *Fergusite* (fergusose), a rather coarse-grained, pseudo-leucitic augite rock, consisting of orthoclase, nepheline, and diopside; it appears to bear a similar relation to the leucitites that missourite does to the leucite basalts. In describing the petrographic characters of the necks, dykes, and extrusive flows, the new nomenclature is used concurrently with the old, so that the conservative reader need not be dismayed by "Trachyphyro-Highwoodose," "grano-shoshonose," or what not. The author concludes with some suggestive remarks on magmatic differentiation.

The annual report of the United States Geological Survey (8) is, as usual, a record of excellent organisation and of abundant energy in all departments.

The twenty-ninth annual report on the geology and natural resources of Indiana (9) contains a monograph of some 650 pages, by Prof. Blatchley, on the clays and clay industries of the State, the reports of the inspectors of mines and natural gas, a paper on the utilisation of convict labour in making road material, an account of the petroleum industry in Indiana in 1904, and a paper on the insect galls of Indiana.

The section on clays is very much like similar reports with which we are becoming daily more familiar; it is an excellent report of its kind. It describes in detail the clay resources of each county, with geological information and analyses; suggestions are given as to available clays and shales that are as yet unworked, and advice is given as to the best way of dealing with them. The use of bricks for road-making is strongly advocated, and the full specifications for the construction of brick pavements in the city of Terre Haute are given; these may prove of interest to those in this country who favour this type of road—the brick roads in Terre Haute have given great satisfaction. The report is illustrated with photographs and maps, and with full statistics of the various branches of the clay industry.

The paper on insect galls, by Dr. Cook, is little more than a catalogue of the galls known in the State. It is provided with a simple introduction to the subject and a bibliography, and with numerous outline sketches and photographs. It should be appreciated in the State. We are not aware that the papers mentioned above are issued separately; if this is not the case it seems unfortunate, for they appeal to such divergent interests.

NO. 1894, VOL. 73]

The summary report of the Geological Survey of Canada (10) for 1904 indicates considerable activity in all quarters of the Dominion. A striking illustration of the usefulness of the survey lies in the discovery of a coal seam 10 feet thick in a bore-hole 2340 feet deep in Cumberland, Nova Scotia. This bore-hole was sunk through a thick cover of unproductive rocks at the suggestion of Mr. Hugh Fletcher, of the Geological Survey staff, after he had worked out the structural geology of the district.

In the Purcell Range, Dr. Daly records an enormous sill of hornblende-gabbro, 2500 feet thick; this he calls the "Moyie sill," from its occurrence at a point where the Moyie River crosses the international boundary. This great mass of basic rock has been thrust into the pre-Cambrian Kitchener quartzite, with the result that its upper portion, some 200 feet thick, has been converted into an acid biotite-granite by assimilation of the siliceous sediment. This has come about principally through the agency of "gravitational differentiation" following the shattering of the quartzite by the heated contact.

Prospecting for iron by means of the magnetometer (Thalen-Tiberg form), an innovation in Canada, seems to have had good results in Charlotte County, New Brunswick. Dr. Barlow contributes some notes on the occurrence of corundum in the intrusive complex of Robillard Mountain at Craigmont. The corundiferous rocks are of syenitic or gabbroid type; scapolite and nepheline often accompany or replace the prevailing feldspars. Some of the syenite contains as much as 34 per cent. of corundum.

J. A. H.

THE PERIODICITIES OF SUN-SPOTS.¹

EVERYBODY knows how to interpret the curve by means of which the intensity of radiation of a body is expressed in terms of the wave-length or frequency, and everybody recognises the utility of such a curve. It allows us at once to distinguish between the line spectrum and the spectrum of bands or the continuous spectrum, and brings out regularities which would be difficult to recognise in the original disturbance. In practice we employ the spectroscope to give us the data from which the curve of intensities is constructed. But what the spectroscope can do for a luminous disturbance, calculation can do for any quantity which fluctuates about a mean value. We are able, therefore, to construct in every case a curve which in all respects is analogous to the graph which connects the period and intensity of radiation. This curve I call the periodograph, and refer to the diagram embodying the curve as the periodogram. There is a periodogram of rainfall or barometric change, and these curves would, in my opinion, if constructed for different localities, yield us most important and characteristic information about climate.

During the last three years I have been occupied in calculating the periodogram of sun-spot variability. The results have been communicated to the Royal Society, and the following is a summary of abstracts which are published in the *Proceedings* of that society. The first paper deals with a detailed examination proving that the process I employ furnishes an analysis which is identical with the experimental spectrum analysis supplied by the grating. In the second paper the method is applied to the statistics of sun-spots.

The data used were Wolf and Wolfer's sun-spot numbers, which give us sufficient information from the year 1749 to the present time. I have in addition used, wherever possible, the measurements of areas which for each synodic revolution of the sun have been collected by the Solar Physics Committee of the British Board of Education from the year 1832 onwards, and the areas measured from photographs at the Greenwich Observatory for each day of the year since January 1, 1883.

The whole of the observations were treated collectively, but the complete interval of 150 years was also divided into two nearly equal portions, which were separately examined. At first sight, the results obtained by a com-

¹ Abstract of two papers, entitled, (1) "The Periodogram and its Optical Applications"; (2) "The Periodicity of Sun-spots." Read before the Royal Society on December 7, 1905.